# Intracranial aneurysm rupture risk factors

The clinical ability of radiomics to predict intracranial aneurysm rupture risk remains unexplored. Turhon et al. aim to investigate the potential uses of radiomics and explore whether deep learning (DL) algorithms outperform traditional statistical methods in predicting aneurysm rupture risk.

This retrospective study included 1740 patients with 1809 intracranial aneurysms confirmed by digital subtraction angiography at two hospitals in China from January 2014 to December 2018. We randomly divided the dataset (hospital 1) into training (80%) and internal validation (20%). External validation was performed using independent data collected from Hospital 2. The prediction models were developed based on clinical, aneurysm morphological, and radiomics parameters by logistic regression (LR). Additionally, the DL model for predicting aneurysm rupture risk using integration parameters was developed and compared with other models.

The AUCs of LR models A (clinical), B (morphological), and C (radiomics) were 0.678, 0.708, and 0.738, respectively (all p < 0.05). The AUCs of the combined feature models D (clinical and morphological), E (clinical and radiomics), and F (clinical, morphological, and radiomics) were 0.771, 0.839, and 0.849, respectively. The DL model (AUC = 0.929) outperformed the machine learning (ML) (AUC = 0.878) and the LR models (AUC = 0.849). Also, the DL model has shown good performance in the external validation datasets (AUC: 0.876 vs 0.842 vs 0.823, respectively).

Radiomics signatures play an important role in predicting aneurysm rupture risk. DL methods outperformed conventional statistical methods in prediction models for the rupture risk of unruptured intracranial aneurysms, integrating clinical, aneurysm morphological, and radiomics parameters.

Key points: • Radiomics parameters are associated with the rupture risk of intracranial aneurysms. • The prediction model based on integrating parameters in the deep learning model was significantly better than a conventional model. • The radiomics signature proposed in this study could guide clinicians in selecting appropriate patients for preventive treatment <sup>1)</sup>.

In Kazakhstan a study has revealed that younger, smoking patients with stage 3 arterial hypertension are at higher risk for Ruptured intracranial aneurysms (RIA). Small intracranial aneurysms (< 6 mm) and location on ACA had increased odds of rupture, while larger aneurysms on internal carotid arteries had lower odds<sup>2)</sup>

Risk factors include:

#### Smoking

see Smoking and aneurysm rupture risk factor

#### **Arterial hypertension**

High blood pressure. High blood pressure damages and weakens arteries, making them more likely to

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form and to rupture.

## Size

Size. The largest aneurysms are the ones most likely to rupture in a person who previously did not show symptoms.

## Location

Location. Aneurysms located on the posterior communicating arteries (a pair of arteries in the back part of the brain) and possibly those on the anterior communicating artery (a single artery in the front of the brain) have a higher risk of rupturing than those at other locations in the brain.

#### Growth

Growth. Aneurysms that grow, even if they are small, are at increased risk of rupture.

## **Family history**

A family history of aneurysm rupture suggests a higher risk of rupture for aneurysms detected in family members.

# Vitamin D

Epidemiological studies show a strong association between decreased vitamin D levels and an increase in aneurysm rupture. However, the causality and mechanism remain largely unknown. Kimura et al. tested whether vitamin D deficiency promotes aneurysm rupture and examined the underlying mechanism for the protective role of vitamin D against the development of aneurysm rupture utilizing a mouse model of intracranial aneurysm. Mice consuming a vitamin D-deficient diet had a higher rupture rate than mice with a regular diet. Vitamin D deficiency increased proinflammatory cytokines in the cerebral arteries. Concurrently, vitamin D receptor knockout mice had a higher rupture rate than the corresponding wild-type littermates. The vitamin D receptors on endothelial and vascular smooth muscle cells, but not on hematopoietic cells, mediated the effect of aneurysm rupture. The results establish that vitamin D protects against the development of aneurysmal rupture through the vitamin D receptors on vascular endothelial and smooth muscle cells. Vitamin D supplementation may be a viable pharmacologic therapy for preventing aneurysm rupture <sup>3</sup>.

## **Multiple aneurysm**

The greatest risk occurs in individuals with multiple aneurysms who have already suffered a previous rupture or sentinel bleed.

Results suggest that high cotinine levels in smokers with brain aneurysms are significantly associated with high rupture risk, independently of smoker status, age, and sex <sup>4)</sup>

## Cerebrovascular atherosclerotic stenosis

Cerebrovascular atherosclerotic stenosis (CAS) and intracranial aneurysm (IA) have a common underlying arterial pathology and common risk factors, but the clinical significance of CAS in IA rupture (IAR) is unclear. A study of Feng et al. aimed to investigate the effect of CAS on the risk of IAR.

They observed substantial differences in the severity of atherosclerotic stenosis, parent-artery stenosis, number of stenotic arteries, and intracranial/extracranial stenosis as indicators between ruptured and unruptured aneurysms. CAS is significantly associated with the risk of intracranial aneurysm rupture, whether in patients aged  $\geq$ 65 years or <65 years. These findings indicate the clinical significance of CAS in IAR <sup>5)</sup>.

1)

3)

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Last update: 2024/06/07 02:57